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OIL AND GAS IN OKLAHOMA

GEOLOGY OF PAWNEE COUNTY

By
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FOREWORD

In 1917 the Oklahoma Geological Survey issued Bulletin 19, Part II, entitled "Petroleum and Natural Gas in Oklahoma." This volume was so popular that the supply was soon exhausted, and for several years copies have not been obtainable.

The present Director has seen the need of a revision of this bulletin. On account of the lack of appropriations he has not been able to employ sufficient help to compile the data, and has called on some twenty representative geologists throughout the state to aid in the preparation of reports on separate counties. These gentlemen, all busy men, have contributed freely of their time and information in the preparation of these reports.

It will be understood that the facts as set forth in the various reports represent the observation and opinion of the different men. The Oklahoma Geological Survey has every confidence in the judgment of the various authors, but at the same time the Survey does not stand sponsor for all statements made or for all conclusions drawn. Reports of this kind, are at best, progress reports, representing the best information obtainable as of the date issued, and doubtless new data will cause many changes in our present ideas.

The chapter on Pawnee County has been prepared by Mr. Frank C. Greene of Tulsa. Mr. Greene is considered by those who know to be one of the best informed men on petroleum geology in the State of Oklahoma. He has had much personal experience in Pawnee County and, at the same time, has had access to information of other men engaged in the same line of work. The data thus secured have been utilized in the preparation of this chapter.

CHAS. N. GOULD,
Director

February, 1928.

PAWNEE COUNTY

By

Frank C. Greene

INTRODUCTION

LOCATION AND AREA

Pawnee County is situated in the north-central part of the State, forming a triangular wedge between Osage County and the south edge of the "Cherokee Strip." The Arkansas River forms the northern boundary of the county and separates it from Osage County. Included within its borders are all or parts of T. 20 N., Rs. 5-10 E., T. 21 N., Rs. 4-9 E., T. 22 N., Rs. 3-7 E., T. 23 N., Rs. 3-6 E., T. 24 N., Rs. 4-5 E., with an area of 584 square miles.

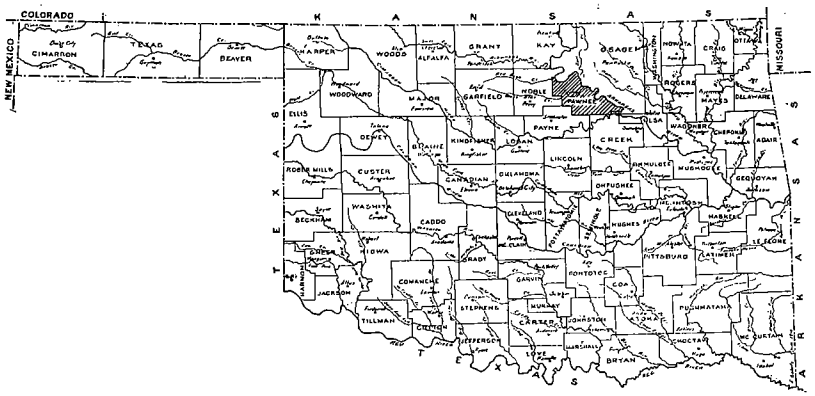

Figure 1.—Map of Oklahoma Showing location of Pawnee County.

DRAINAGE AND TOPOGRAPHY

As mentioned above, the Arkansas River forms the northern boundary and the Cimarron River is not far from the southern boundary, finally entering the county in T. 20 N., R. 9 E., where the junction of the two streams is near the southeast tip of the county. Black Bear Creek crosses the county and empties into the Arkansas River above Blackburn.

The lowest point is at the junction of these two streams, about 650 feet above sea level. The highest point is something over 1,050 feet.

The county is traversed by a series of escarpments capped by sandstones and limestones. In the eastern third of the area sandstones prevail and the country is timbered. In the middle third, limestones and sandstones alternate and there are some prairie belts interspersed with the timber. In the western third, on the red beds, prairie predominates.

DEVELOPMENT

Pawnee was one of the early counties to enter the ranks of the oil producers, a well having been completed on Cleveland townsite in September, 1904. The eastern third of the county contains many pools which are described in this report. In the western two-thirds, developments have been fewer and the pools are rather scattered.

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness to Percy Fly of the Skelly Oil Company of Tulsa, for his assistance in compiling data, and to the Skelly Oil Company for use of the plotted logs in compiling the information on stratigraphy.

STRATIGRAPHY

Pre-Cambrian Granite

All the sedimentary formations encountered in drilling rest upon granite or some other type of igneous rock. Five wells in or near Pawnee County have been drilled into granite. Needless to say, a well cannot be drilled through the granite and, in the search for oil and gas, it is entirely useless to try to drill through it. While oil has been found in the upper part of the weathered granite, or "granite wash", or other types of igneous rocks, it is not likely to be found in granite in Pawnee County.

A hole in the SW. cor. SE.¼ sec. 19, T. 21 N., R. 9 E., went into granite at 3,200 feet or 2,316 feet below sea level. In the NW. cor. NE.¼ sec. 9, T. 20 N., R. 8 E., granite was encountered at 3,130 feet or 2,102 feet below sea level. Another in the same section, NE. cor. NW.¼ NW.¼, found granite at 3,058 feet or 2,039 feet below sea level and in the same area, in the NE. cor. SE.¼ SW.¼ sec. 3, granite was encountered at 3,215 feet or 2,314 feet below sea level.

A few miles south of Pawnee County granite was found at 3,887 feet (3,050+ feet below sea level) in the NW. cor. SE.¼ SW.¼ sec. 32, T. 19 N., R. 7 E.

The deepest holes stratigraphically in the western part of the county are in the NE. cor. NW.¼ sec. 10, T. 22 N., R. 4 E., bottomed at 4,740 feet in brown lime (3,735 feet below sea level), and 775 feet below the top of the Ordovician and in the SW. cor. sec. 29, T. 23 N., R. 5 E., with a total depth of 4,635 (3,707 feet below sea level) and 978 feet below the top of the Ordovician.

Cambrian and Ordovician

The Cambrian and Ordovician of this region include 170 to probably 1,500 feet of strata. On the tops of structural highs, there is probably no Cambrian and the thickness of the Ordovician is much less than normal. Each high constitutes a problem unto itself. The normal off-structure section will probably include some Cambrian beds (sandstone and limestone) at the base, a thick series of Ordovician limestones, sandy limestones and dolomites ("siliceous lime"), passing up through green and red shales, sandy shales, thin sandstones and limestones to the Wilcox sand at the top. In the northern part of the county, it is estimated that the thickness will be around 1,200 feet, increasing to the south.

In some areas the Wilcox sand is absent from the tops of domes and the overlying Chattanooga rests on the green shale or "siliceous lime" while in others, limestone (Viola) is present.

The "siliceous lime" and Wilcox are important oil and gas reservoirs.

Mississippian

CHATTANOOGA SHALE

Practically the entire area of the county is underlain by the Chattanooga shale with an average thickness of about 50 feet. It is a black homogeneous shale, containing no gritty material, but with much pyrite. It is full of small brown crinkled discs of *Sporangites,* which can always be found upon careful microscopic examination.

It is the writer's opinion that the original substance of these spores, once spheres, but now flattened into discs, of which there are millions in each cubic foot of shale, is the source of most of the oil found in the Wilcox sand and associated strata.

The Misener sand, locally found at the base of the Chattanooga shale, is an important oil-bearer in Payne County, which joins Pawnee County on the south. In some cases, it is impossible to state definitely whether a given sand is Wilcox or Misener.

"MISSISSIPPI LIME"

The normal thickness of the "Mississippi lime" is about 300 feet but, like the lower formations, it is greatly reduced or absent on top of some of the structural highs. It is variously logged as white, black, gray, and brown lime, with sands or sandy phases.

The upper part, where porous, constitutes the "first break in the lime" of old-time operators. It yields showings of both oil and gas in many cases, and in a few instances, commercial production.

Pennsylvanian and Permian

GENERAL DISCUSSION

The formations exposed at the surface include about 2,500 feet of gray and red shales, brown, buff, gray and red sandstones and limestones, mostly of Pennsylvanian age, but including some Permian in Ranges 3, 4, and 5 East, according to the adopted classification. There is no break in sedimentation at the contact. In the southwestern part of the county the base of the Pennsylvanian is about 4,000 feet deep and in the eastern end about 2,600 feet. The discrepancy is caused by the thickening of the lower Pennsylvanian beds to the east. (See Plates I and II)

CHEROKEE SHALE

Near the base of the Pennsylvanian is a widespread "red bed", present over most of the county, but somewhat irregular in Ranges 8 to 10 East. In places it rests on the "Mississippi lime" and in others, is 100 feet or more above it. In a few places the intervening shale con-

tains a sand, variously termed Tucker, Burgess, Dutcher, or Bartlesville. It is generally believed, however, that the Bartlesville sand is absent in areas where this red bed is present. This sand, by whatever name the operator chooses to call it, has yielded some production. The noteworthy well of the Duquesne Petroleum Company in sec. 8, T. 21 N., R. 6 E., was in this sand. It came in at 600 barrels, but dropped rapidly and did not produce very long.

The Bartlesville sand, as known in the eastern part of Osage County, is present in the eastern part of Pawnee County, 100 feet thick to the east and feathering out to the west. It is an important producer of oil and gas.

The next higher sand is the Red Fork. It is lenticular, but appears in patches in many parts of the area. It is termed "Bartlesville" sand in the western part of the county and probably is the Burbank sand of western Osage County. Another possibility is that the two sands are united in places in eastern Pawnee County and southeastern Osage County, and together are termed Bartlesville sand.

The "Pink lime" appears to be persistent throughout the county and constitutes a reliable marker for correlation and contouring. It is above the Bartlesville sand of the western part of the county and above the Red Fork in the eastern part.

Next above the "Pink lime" is the Skinner sand, an important producer in the eastern part of the county. It is succeeded by the lower or "Little" Oswego lime and that in turn by the Prue sand. The Prue is somewhat lenticular, but is an important sand. In the true application of the term Cherokee, the lower Oswego lime (base of the Fort Scott limestone) marks the top of the Cherokee.

The Cherokee is about 650 feet thick in the eastern end of the county and thins to 350 feet in the northwestern part.

OSWEGO-BIG LIME

This series of limes is about 150 feet thick, but is rather variable. It consists of limestones and interbedded black shales. The top is rather irregular, and while the series as a whole constitutes a good marker, the individual beds are rather difficult to correlate in many places. For this reason it is not a reliable bed for contouring, although locally it can be used.

As to the proper correlation of the various members of the series of limestones, the writer believes it includes both the upper Oswego and the Big Lime as used by drillers in the Osage, but this question has not been entirely settled.

The upper bed is locally porous and is believed to be the producing formation in the Bement well in sec. 30, T. 23 N., R. 5 E.

INTERVAL FROM BIG LIME TO AVANT LIME

This interval varying from 1,200 feet in the eastern part of the county to 750 feet in the northwestern, contains three important oil sands and several persistent limestones. In the eastern area shale makes up the greater part, while in the western area, the shales not only thin

but sandstones and limestones increase. The top is marked by a thick zone of sandstones and red beds with the Avant limestone at the contact.

The lowest sand is the Cleveland, and in places it is divided by a shale parting. In the Keystone pool the upper bed is known as the Dillard sand. It is probable that in many places only one or the other of the two layers is present and that the name Cleveland is applied to it indiscriminately. This sand was named from the early production found in it on the townsite of Cleveland.

Above the Cleveland sand is the Checkerboard lime, a thin but very persistent bed. It is about 300 feet above the Big Lime in the eastern part of the county but only 125 feet in the northwestern part.

The Layton sand (of Bristow and Cushing) is the next higher sand. It is a zone of one or two thick or thin sands. About 30-50 feet above it is the Lost City (Hogshooter) limestone, which is thin and irregular in most of Pawnee County. The Layton sand as here used is believed to be present as a thin sand below the Layton sand of the Watchorn pool (Tps. 22 and 23 N., R. 3 E.) as defined by Carpenter.[1]

The next higher sand is the Peoples sand of the Cleveland district. It is persistent and thick. At the base there is a fairly persistent limestone and locally a thin layer of red shale. There is a thin limestone just above it and about 50 feet above it, is the Dewey limestone. This limestone is found in practically every well from R. 4 E., to the east line of the county and constitutes an excellent marker. West of R. 4 E., in the Watchorn pool, it appears to be replaced by sandstone.

According to a long series of correlated logs, it appears that the Peoples sand is the Layton sand of the Watchorn pool and the pools to the northwest in Noble, Kay, Grant, and Garfield counties.

BRISTOW FORMATION

The Bristow formation is 800 feet thick in the eastern part of the county and 1,050 feet in the northwestern part. It consists of three zones of interstratified sandstone, limestone, and red shale, and three zones of blue shale and thin limestone, two of them separating the sandy zones and the third at the top of the formation.

It does not contain any important oil sand in Pawnee County, but correlations indicate that the middle and lower Hoover sands and the Tonkawa sand of Noble and Kay counties belong in the Bristow.

ELGIN SANDSTONE

The Elgin sandstone consists of one or more beds of sandstone with interbedded shales, the whole having a thickness of 50 to 100 feet. It is the upper Hoover sand of the Tonkawa field.

HIGHER FORMATIONS

The following is a section of the outcropping rocks from the Elgin sandstone to the highest beds in the county. Nearly all the limestones furnish excellent beds for surface mapping.

1. Carpenter, Everett, The Morrison Field, Pawnee County, Oklahoma: Bull. Amer. Assoc. Pet. Geol. vol. 11, no. 10, pp. 1087-1096, Oct. 1927. (This paper is included in the present report; see pp. 21-28).

Sections from Pawnee east to Cleveland.

Bed No.	Description	Thickness of Bed (feet)	Total
1.	Limestone, fine-grained, siliceous, gray, weathers light brown, has many cavities, lined with calcite; 1-2 feet thick. (Neva)	1½	1½
2.	Sandstone, gray, weathering brown, fossiliferous, calcareous in places, 2-5 feet	3½	5
3.	Shale, red and gray	3	8
4.	Sandstones and red and gray shale. At top is "Standpipe sandstone" which is fairly persistent, 10 feet below, section is variable	40	48
5.	Limestone, gray, nodular, conglomerate, or gray, calcareous, thin-bedded sandstones, 3-8 feet	5	53
6.	Shale, red and gray, with locally a sandstone up to 5 feet thick near base, 22-30 feet	27	80
7.	Limestone gray, composed chiefly of small fragments of crinoids and other fossils where exposed near National Hotel at Pawnee; to south becomes impure, sandy and nodular, 2-4 feet (Red Eagle)	3	83
8.	Shale, red and gray, and sandstone	34	117
9.	Limestone, buff, composed of **Fusulina**, rarely outcrops (Top of Foraker)	½	117½
10.	Shale, gray	2½	120
11.	Limestone dark-gray, hard, very fossiliferous, especially brachipods	2	122
12.	Shale, red and gray, with local sandstone	39½	161½
13.	Limestone, buff (1-2 feet), underlain by gray, shaly limestone, or calcareous shale 1½-2 feet	3½	165
14.	Limestone, gray, in two layers, upper 8-10 inches, lower 10-12 inches	1½	166½
15.	Shale, soft, blue, possibly thicker in places	10½	177
16.	Limestone, gray, in 3 layers, with shale between, locally weathers brown. (base of Foraker)	3	180
17.	Shale, red or gray	20	200
18.	Sandstone, brown. massive, max. 25 feet, locally absent, and shale with 2 or 3 thin limestones in this interval	25	225
19.	Shale	5	230
20.	Limestone, gray, upper 1½ feet thick, very fossiliferous on upper surface, shaly limestone below	2	232

Sections from Pawnee east to Cleveland, (Cont'd.)

Bed No.	Description	Thickness of Bed (Feet)	Total
21.	Shale, with a thin, slabby, sandy limestone 10 feet below top and locally a thick sandstone below, shale mostly red	73	305
22.	Limestone, gray, crinoidal, nodular, rarely well exposed	1	306
23.	Shale, red and white, with locally a sandstone occupying lower 25-50 feet of interval	69	375
24.	Limestone, gray, upper 6-12 inches locally nodular. thin-bedded below, many layers composed of **Fusulina**—forms a prominent escarpment [Burlingame (?) of Kansas]	7	382
25.	Shale, with 1 or 2 layers of buff, shaly, very fossiliferous limestone—**Mayalina** very abundant. (Possibly Grayhorse)	10	392
26.	Shale, with locally a sandstone up to 35 feet thick, the top of which is 20--25 feet below top of No. 24	38	430
27.	Limestone, gray	1	431
28.	Shale, with local sandstone and conglomerate	19	450
29.	Limestone, nodular, gray mottled with red and green	2	452
30.	Shale, red and gray, with local sandstone, 25-30 feet	28	480
31.	Limestone, gray	1	481
32.	Shale, with calcareous nodules, reddish	4	485
33.	Shale, gray and red, with several thin layers of hard, resistant sandstone in upper half or third	20	505
34.	Limestone, gray with large **Fusulina**, jointed shaly limestone at base. [Top (?) of Stonebraker]	2	507
35.	Shale, gray and red, with local sandstone 30 feet thick	31	538
36.	Limestone, gray in 2 or 3 beds, small **Fusulina**	2½	540½
37.	Shale, with limestone nodules	2	542½
38.	Limestone, gray, with **Fusulina**	½	543
39.	Shale	12	555
40.	Limestone, gray, mottled with red, nodular or with a conglomeratic appearance. (Base of Stonebraker)	2	557
41.	Shale, red and shaly sandstones	28	585
42.	Sandstone, probably locally a red shale	30	615
43.	Limestone, gray to dark-gray, with several shale partings, extremely fossiliferous (**Crypto oon**-bearing limestone)	10	625
44.	Shale, sandy shale, and shaly ss.	20	645
45.	Sandstone, gray or brown	10	655
46.	Shale, red	27	682

Sections from Pawnee east to Cleveland, (Cont'd.)

Bed No.	Description	Thickness of Bed (Feet)	Total
47.	Limestone, gray	1	683
48.	Shale	2	685
49.	Sandstone, bedded, even layers	8	693
50.	Shale, red, purple, gray, and green with 2 or 3 thin, hard layers of sandstone that resemble limestone	17	710
51.	Limestone, gray, in two layers. (Bird Creek)	1⅔	711⅔
52.	Sandstone and shale	33⅓	745
53.	Limestone, upper 1-3 feet gray, even layered, badly cut by joints; lower part dull and composed of **Fusulina.** (Turkey Run)	2	**747**
54.	Sandstone and shale, with locally thin layers of nodular limestone, variable	73	820
55.	Limestone, mostly thin-bedded and gray (Lecompton)	12	832
56.	Shale and sandstone	100	932
57.	Sandstone, thick, base not seen. (Elgin)	----	----
	Total		932

STRUCTURE

General

Structure has played an important part in the accumulation of oil and gas in Pawnee County. This is not shown in the surface structure in all cases, but a careful survey of subsurface conditions will reveal that practically all the pools of the county are on closed structural highs. This condition is in strong contrast to that prevailing in the shallow pools in eastern Osage County and in Washington County, in the Burbank field, Glenn Pool, and others. This will be discussed further under "Future Development."

Surface Structure

The structure shown by the formations exposed at the surface is fairly simple in the western two-thirds of the county and somewhat more complex in the eastern third, all, however, being merely a modification of the westerly dip prevalent in north-central Oklahoma.

The eastern third of Pawnee County is crossed by the belt of folding and faulting that passes through central Osage County and the Cushing field, in Ranges 7, 8, and 9 East, trending slightly east of north and west of south. It is marked at the surface by *en echelon* faults with a maximum throw of 100 feet and reverse dips of about the same magnitude.

The western two-thirds of the county exhibits a more regular westerly dip, broken in many places by structural noses, terraces, a few *en echelon* faults, and some isolated closed highs.

Subsurface Structure

In general, the structural features shown by the surface beds become more pronounced with depth. (See under Morrison field). After a study of hundreds of graphic logs, it became apparent that the best horizon for contouring the structure of the lower beds is the base of the Chattanooga black shale. (See Plate III). As explained in the discussion of stratigraphy, the Chattanooga rests unconformably on beds of Ordovician age.

The structure shown in Plate III is accurate only to the extent to which logs and well elevations are available. Where wells have been drilled fairly close together and the well elevations are reliable, the map presents an accurate picture of the folding. In other areas it is merely a much generalized picture, subject to revision.

Some of the features shown by this map are discernible at the surface, although reduced in degree of folding, others are probably not represented at the surface. On the other hand, there are doubtless many minor surface features not represented on this map.

The belt of surface folding and faulting mentioned as crossing the eastern third of the county exhibits some very steep dips on the base of the Chattanooga shale. This belt considered in its entirety is comparable with the Nemaha or granite ridge of Kansas and Oklahoma in many ways, although in the literature it has not been given the prominence it deserves.

The western edge of this belt is marked both on the surface and subsurface by steep dips beyond which to the west the dips are gentle. As in the surface structure, the subsurface shows a few noses and closures, but mostly a westerly dip.

DEVELOPMENT

Oil and Gas Pools[2]

ADAMSON POOL

LOCATION: Secs. 31 and 32, T. 21 N., R. 8 E., and sec. 5, T. 20 N., R. 8 E.

DISCOVERY WELL: Not known.

DATE OF OPENING: Not known.

PRODUCING SANDS: Top Mississippi Lime—2,600-2,650; Turkey Mt. sand—2,880-2,980.

REMARKS: Shows in Wilcox and Hominy sands.

CLEVELAND POOL

LOCATION: Secs. 8, 9, 16, 17, 18, 19, 20, 21, 29 and 30, T. 21 N., R. 8 E.

DISCOVERY WELL: Drilled by local capital, Bill Lowery farm, south edge of town.

DATE OF OPENING: September, 1904.

PRODUCING SANDS: Cleveland sand—1,500-1,700 feet deep, about 20 feet thick; Skinner sand, big gas and some oil—2,100-2,200; Bartlesville sand—2,400-2,450.

2. The writer realizes that the information given here is very incomplete and probably in some cases inaccurate. In all compilations of this kind, accurate information concerning oil fields is hard to get and all persons having such information are requested to send it to the State Geological Survey at Norman where it can be placed on file and preserved for the future.

REMARKS: Well in SW.¼ SE.¼ SW.¼ sec. 20, T. 21 N., R. 8 E., made 1 M. gas in sand topped at 560-580. This sand is in lower red beds. The initial production in the Cleveland sand ranged from 25 to 300 barrels. Gravity, 36-37.9°.

KEYSTONE POOL

LOCATION: Secs. 24 and 25, T. 20 N., R. 9 E.
DISCOVERY WELL: Pomeroy and Hamilton, G. W. Besser No. 1, SW. cor. SE.¼ SE.¼ sec. 24, T. 20 N., R. 9 E. Cleveland sand—1,145-1,205. I. P. 75 barrels.
DATE OF OPENING: March 19, 1919.
PRODUCING SANDS: Upper Cleveland sand—1,100-1,200; Skinner big gas—1,690-1,780; Bartlesville—1,950-2,000; Wilcox—2,430-2,500.
REMARKS: Gravity, 36-37.9°.

HALLETT POOL

LOCATION: Secs. 3, 4, 8 and 9, T. 20 N., R. 7 E.
DISCOVERY WELL: Turner Investment Co., McMillan No. 1, NE. cor. SW.¼ sec. 3, T. 20 N., R. 7 E. Sand—2,140-2,150. I. P. 60 to 75 barrels.
DATE OF OPENING: April 6, 1922.
PRODUCING SANDS: The wells in sections 3 and 4 are Cleveland sand—2,100-2,150; the wells in sections 8 and 9 are Prue and Skinner sands; Prue—2,400-2,570, Skinner—2,580-2,700.
REMARKS: Some of the sections listed under the Jennings pool are closer to Hallett than to Jennings and may be considered by some operators to be part of the Hallett pool. There is no sharp line between the two areas.

JENNINGS POOL

LOCATION: Secs. 15, 16, 21, 22, 23, 26, 33 and 34, T. 20 N., R. 7 E., and south in T. 19 N., R. 7 E.
DISCOVERY WELL: Republic Oil and Pipe Line Co., sec. 21, T. 20 N., R. 7 E. I. P. 20 barrels.
DATE OF OPENING: 1916.
PRODUCING SANDS: Skinner sand has some good gas—2,500-2,600; Bartlesville sand has some good oil—2,690-2,750.
REMARKS: Gravity 26-37.9°

LAUDERDALE POOL

LOCATION: Secs. 35 and 36, T. 21 N., R. 7 E., sec. 31, T. 21 N., R. 8 E., secs. 1 and 2, T. 20 N., R. 7 E., and secs. 6 and 7, T. 20 N., R. 8 E.
DISCOVERY WELL: Not known.
DATE OF OPENING: Not known.
PRODUCING SANDS: The Peoples sand—1,170-1,340, has some small gas and oil; Layton sand—1,400-1,600, has some good production; Cleveland sand—1,700-2,100, has some good production; Prue sand—2,200-2,400, has some small production; Skinner sand—2,300-2,450, has some good production; Bartlesville sand—2,400-2,550, has some good production; Wilcox sand—2,522-2,740, has some good production; Turkey Mountain sand—2,575-2,800, has some good production.
REMARKS: Two sands above the Peoples sand have shows of gas and oil. The Cleveland sand is divided into two parts, Upper and Lower, by a shale from 50 feet to 150 feet in thickness. In the highest part of the pool the Turkey Mountain sand is about 30 feet under the Bartlesville.

MANNFORD

LOCATION: Sec. 36, T. 20 N., R. 8 E.
DISCOVERY WELL: Gillette No. 1, School Land, NE.¼ NE.¼ SW.¼, sec. 36. I. P. 1,000 barrels.
DATE OF OPENING: April 5, 1922.
PRODUCING SANDS: Wilcox—2,880-2,985.

MARAMAC POOL

LOCATION: Secs. 4, 5, 8, 9, 16, 17, 21, 22, 27, and 28, T. 20 N., R. 6 E.
DISCOVERY WELL: Not known.
DATE OF OPENING: 1920.
PRODUCING SANDS: Bartlesville sand, small production in Layton, Cleveland, Oswego, Prue, Skinner, Burgess, and Wilcox. Depth of Bartlesville—3,040-3,100.
REMARKS: Gravity, 38°.

MASHAM POOL (DONAHOE POOL)

LOCATION: Sec. 22, T. 23 N., R. 4 E.
DISCOVERY WELL: Donahoe et al., No. 1, Zoldoski, NW. cor SE.¼, sec. 22. Top of sand—3,717. I. P. 730 barrels.
DATE OF OPENING: Dec. 14, 1924.
PRODUCING SANDS: Wilcox—3,694-3,750.
REMARKS: The first well in this area was a gas well drilled by J. Alex Dingwall exactly one mile south of the discovery well in the NW. cor. SE.¼, section 27. This was dry in the Wilcox sand but made 5½ million gas in a higher sand.

MINNEHOMA POOL

LOCATION: Secs. 13 and 24, T. 21 N., R. 7 E.
DISCOVERY WELL: Minnehoma, No. 3-W, Merrall, SW.¼ SE.¼ SW.¼, sec. 13, T. 21 N., R. 7 E. I. P. 75 barrels.
DATE OF OPENING: June 30, 1926.
PRODUCING SANDS: All sands had shows of oil and gas but the production came from the Hominy—2,630-2,725.

MORRISON (WATCHORN) POOL[3]

LOCATION: Secs. 32 and 33, T. 23 N., R. 3 E., and secs. 4 and 5, T. 22 N., R. 3 E.
DISCOVERY WELL: Robert Watchorn, Geo. L. Miller No. 1, NE. cor. SW.¼ SW.¼ sec. 33, T. 23 N., R. 3 E. 35,000,000 cubic feet of gas in Tonkawa sand.
DATE OF OPENING: December 27, 1915.

3. See discussion of Morrison field, by Everett Carpenter, p. 21.

PRODUCING SANDS: Tonkawa and other gas sands—2,000-2,500 feet; Layton sand—oil, at 2,752 feet, July 14, 1922; Wilcox sand—650 barrels at 3,800 feet, October, 1923.

REMARKS: This pool is on a closed structure which was found by Frank Buttram, employed by the Fortuna Oil Company. The holdings of the Fortuna were later sold to the Magnolia Petroleum Company.

QUAY POOL

LOCATION: Sec. 31, T. 20 N., R. 6 E., sec. 36, T. 20 N., R. 5 E., and extending south in Payne County.

DISCOVERY WELL: Not known.

DATE OF OPENING: 1914.

PRODUCING SANDS: Bartlesville—3,150-3,210.

REMARKS: Gravity, 36 to 37.9°.

RALSTON POOL

LOCATION: Northern part of T. 23 N., R. 5 E.

DISCOVERY WELL: J. M. Critchlow et al., sec. 3, T. 23 N., R. 5 E.

REMARKS: Gravity, 36-37.9°.

SOUTH CLEVELAND (OLNEY) POOL

LOCATION: Secs. 25, 26, 27, 34 and 35, T. 21 N., R. 8 E., and secs. 2, 3, 4, 5, 8, 9, 10 and 11, T. 21 N., R. 8 E.

DISCOVERY WELL: Chas. Page, sec. 34, T. 21 N., R. 8 E., 2 million cubic feet of gas at depth of 1,400 feet.

DATE OF OPENING: 1915.

PRODUCING SANDS: Red Fork—2,300-2,600; Bartlesville—2,400-2,700.

SOUTHWESTERN POOL

LOCATION: Secs. 13, 23 and 24, T. 20 N., R. 8 E.

DISCOVERY WELL: Not known.

DATE OF OPENING: Not known.

PRODUCING SANDS: Layton sand—1,100-1,200; Cleveland sand—1,400-1,600; Skinner has some big gas 2,000-2,140; Red Fork, some gas and oil—2,140-2,300; Bartlesville—2,220-2,350; Wilcox— 2,730-2,870.

TERLTON POOL

LOCATION: Secs. 19 and 30, T. 20 N., R. 8 E.

DISCOVERY WELL: Not known.

DATE OF OPENING: 1912.

PRODUCING SANDS: Skinner sand—2,415-2,490.

WEST QUAY POOL

LOCATION: Sec. 33, T. 20 N., R. 5 E.

DISCOVERY WELL: Marland No. 1, School Land, NW.¼ NW.¼ SE.¼, sec. 33. I. P. 25 barrels.

DATE OF OPENING: February 22, 1922.

PRODUCING SANDS: Wilcox—2,670-3,700.

REMARKS: The discovery well drilled in sec. 2, T. 22 N., R. 22 E., was not offset until September 29, 1926. This was in the NE.¼ NE.¼ SW.¼ of the section and the third well in the pool with an initial production of 398 barrels. The second well was drilled in August 20, 1926, in the SE.¼ SE.¼ SW.¼ of the section with an initial production of 60 barrels.

MINOR POOLS AND IMPORTANT SHOWINGS

Kelly-Chandler, No. 1 Hill, NE. cor. SW.¼, sec. 1, T. 21 N., R. 5 E., drilled in August 27, 1924, at a depth of 3,379 feet in Wilcox sand, swabbed 200 barrels. 30 per cent salt water, gravity, 48½°.

Bement Oil and Gas Co., No. 1 Box, SE. cor. SW.¼, sec. 30, T. 23 N., R. 5 E., drilled in May 23, 1925, produced 95 barrels from Big Lime (?) at 2,762-72 feet.

Duquesne Pet. Co., Chas. Colclazier No. 1, SW. cor. NE.¼ SW.¼, sec. 8, T. 21 N., R. 6 E., completed August 21, 1923, at 2,985 feet. I. P. 660 barrels, but soon dropped off and was drilled to Wilcox without production.

Ranch Creek Pool, sec. 20, T. 21 N., R. 7 E. There are a few wells believed to be in the Skinner sand. Drilled in 1915 or earlier by the Uncle Sam Oil Company.

Devonian Pool. Opened May 6, 1926, by Devonian Oil Co., et al., No. 1, on W. M. Longmire farm, SE. cor. NW.¼, sec. 35, T. 22 N., R. 6 E. Initial production, 40 barrels. Sand—2,660-2,671.

Future Development

As already mentioned, nearly all the production so far found in Pawnee County is closely associated with structure. Practically the entire area of the county contains outcrops of a type that permits accurate mapping of the ledges and contouring of the structural features. This led to early exploration and development, with the result mentioned.

It is believed that all of the closed structures and most of the prominent structural noses and terraces have been tested. However, the minor features sometimes furnish surprises, and before the structural production possibilities can be said to be really exhausted, all these minor features must be tested. It should be remembered, however, that in considering these, even though they are based on very careful mapping of the beds exposed at the surface, they are only of minor importance.

Of the future of the non-structural production, there is little to be said, but much to be learned. Neither surface nor subsurface structure is an accurate clue to the location of sand lenses or shoe string sands, yet some of the best fields of the Mid-Continent are of this type.

It is believed that future drilling will reveal some pools of this type in Pawnee County and that the future of the county as an oil and gas producer depends on exploration with the drill for non-structural production.

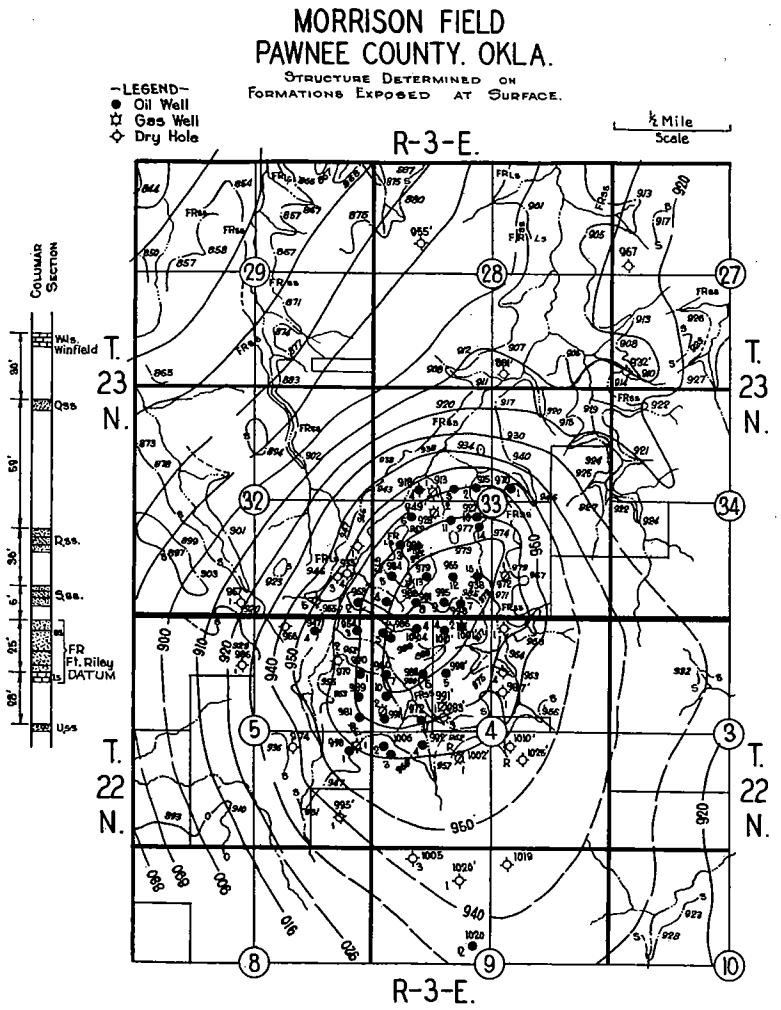

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Figure 2.—Geologic structure of the surface formations, Morrison field. Contours above sea-level. Contour interval, 10 feet.

THE MORRISON FIELD, PAWNEE COUNTY OKLAHOMA[4]

By

Everett Carpenter[5]

Bartlesville, Oklahoma

LOCATION

The Morrison field is located in T. 22 and 23 N., R. 3 E, Pawnee County, Oklahoma. It lies southeast of the Kay County district, with which it is closely related as regards structure and producing horizons. It has a producing area of only about 320 acres, but has produced 4,566,800 barrels of oil at the close of 1926.

HISTORY

The history of the Morrison field commences with the year 1915. The structure was discovered in January of that year by Frank Buttram, who was then employed by the Fortuna Oil Company. The first well George L. Miller No. 1, was completed by Robert Watchorn on December 27, 1915, as a 35,000,000-cubic foot gas well in the Tonkawa sand. During the interval between 1915 and 1922 the development was confined to the gas sands found between 2,000 and 2,500 feet, but on July 14, 1922, George L. Miller No. 3 was completed as an oil well in the Layton sand, found at 2,752 feet. This well was deepened to the "Wilcox" sand in October, 1923, and had an initial production of 650 barrels.

STRATIGRAPHY

The rocks exposed at the surface in the Morrison field are of Permian age. They consist mostly of red shale and sandstone, but two limestones are present. The Fort Riley limestone outcrops in the field and is the datum used in mapping the structure. This formation has lost the calcareous nature it possesses in Kansas and northern Oklahoma, and consists mostly of sand, with a limestone bed about 10 feet thick at its base. The Winfield limestone outcrops west of the field about 160 feet stratigraphically above the Fort Riley. The interval between the two consists of red sand and shale.

SUBSURFACE STRATIGRAPHY

Subsurface correlations in the Morrison field are comparatively difficult, due to the lack of persistent key beds. The Foraker limestone is found 500 feet below the Fort Riley, but it is not easily recognized. The first dependable correlation to be made is on the Tonkawa sand found at a depth of 2,000 feet. The section between the Tonkawa sand and the Layton sand, found at 2,700 feet, is irregular, and no accurate correlation is possible throughout wide areas. The Layton sand can be correlated in most of the area, and also the Kansas City-Oswego group. The "Mississippi lime" found on the structure at a depth of 3,800 feet below the Fort Riley is always distinguishable; but on account of its variable thickness the depth of the "Wilcox" cannot be definitely forecast.

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5. Presented by title before the Association at the Tulsa meeting, March 26, 1927. Manuscript received by the editor July 30, 1927.

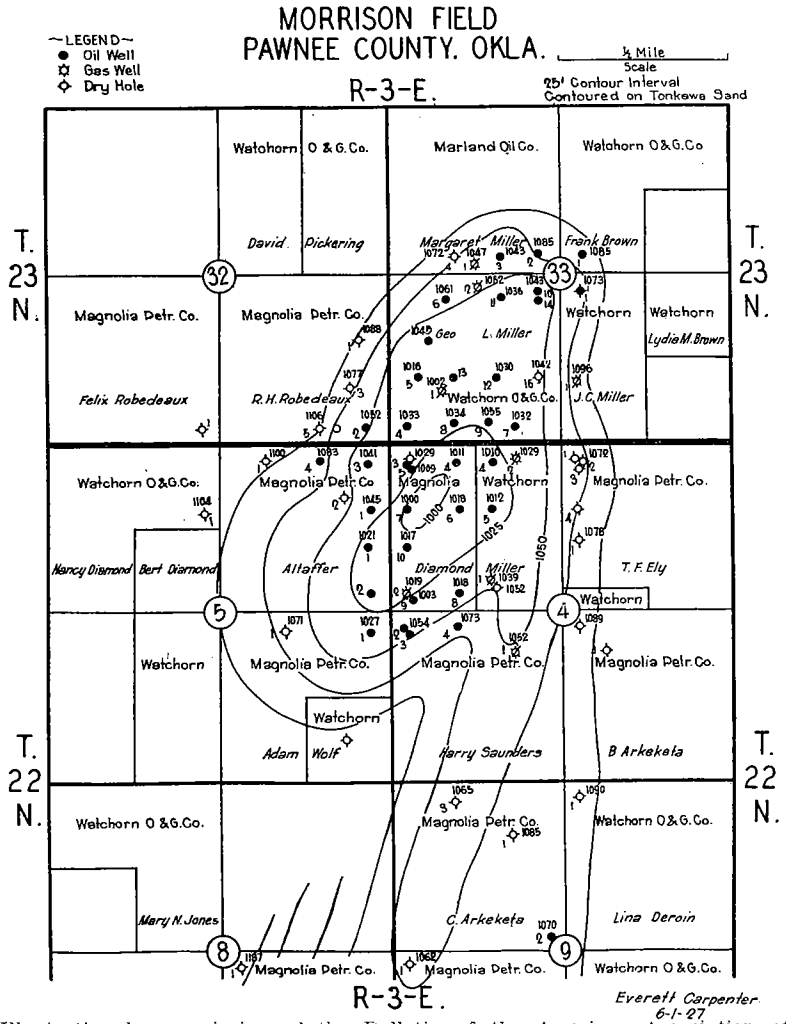

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Figure 3.—Geologic structure contoured on the Tonkawa sand in feet below sea-level, Morrison field.

STRUCTURE

The structure as revealed by the surface rocks is a typical anticline (Fig. 2). It has a north-south length of about one mile and a productive width of about ½ mile (Fig. 1). The fold is characterized by a reverse dip of about 40 feet, although probably not all of the east flank is exposed. The south end of the structure is not clearly revealed, due to the lack of exposures of any key horizons.

Several horizons may be used for subsurface mapping with essentially similar results. For the purpose of this study four horizons were used, namely, Tonkawa, Layton, "Mississippi lime," and "Wilcox" sand (Figs. 3, 4, 5 and 6.) These formations, except the "Mississippi lime," contain oil or gas, and measurements to them are probably more accurate than others. The structure as revealed by subsurface rocks is similar in outline to that determined by surface exposures. In general the amount of closure increases with depth to the top of the "Wilcox" sand, where there is a closure of about 150 feet.

PRODUCTION

The production obtained from the Pennsylvanian strata is mostly gas, although oil has been found in commercial quantities in the Layton sand in several wells at a depth of about 2,700 feet. The producing sands are the Tonkawa gas sand at 2,000 feet, two unnamed gas sands at about 2,300 and 2,500 feet, and the Layton oil sand at 2,700 feet. The Bartlesville sand is probably present on the Morrison anticline, but it is unproductive. Some slight showings were obtained in the upper part of the "Mississippi lime," but they were not sufficient to be commercial.

The production obtained from the pre-Pennsylvanian strata is all from the "Wilcox." It is the best oil-producing formation, and has furnished more than 90 per cent of the oil in the field. It seems that all the oil-bearing horizons have been tested, but several showings in the siliceous lime have been reported in wells drilled off the structure. It is possible that when a deeper well is completed on the top of the dome, additional production may be obtained.

The following production data are from the office of the Corporation Commission and are thought to be accurate:

Production of the Morrison Field

YEAR	BARRELS
1922	42,318
1923	97,576
1924	1,253,080
1925	2,232,996
1926	940,830
Total	4,566,800

At the close of 1926, the average yield for the field was more than 11,000 barrels per acre. The production during the remainder of the life of the field should be almost 15,000 barrels per acre.

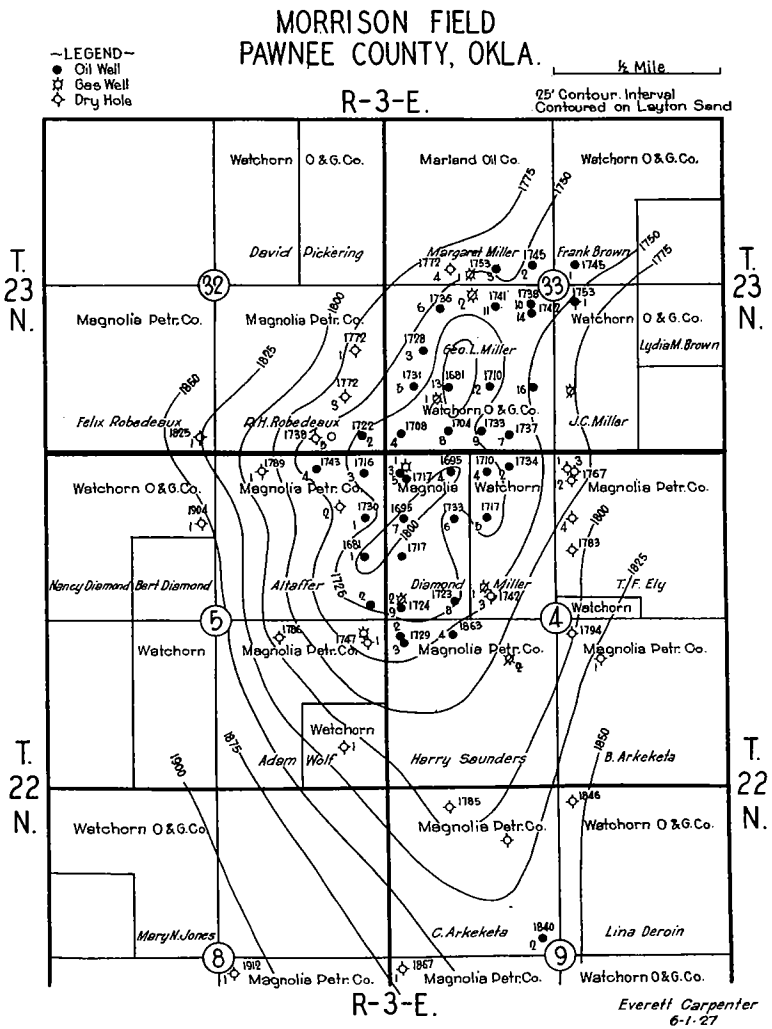

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Figure 4.—Geologic structure contoured on the Layton sand in feet below sea-level, Morrison field.

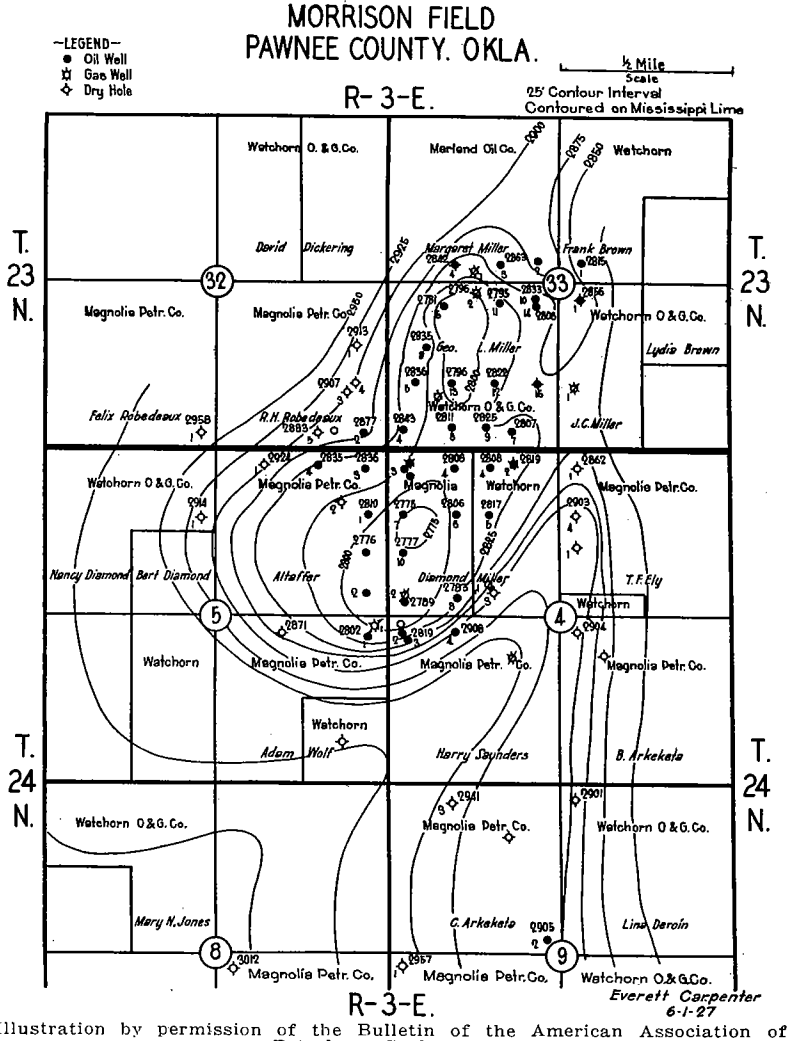

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Figure 5.—Geologic structure contoured on the "Mississippi lime" in feet below sea-level, Morrison field.

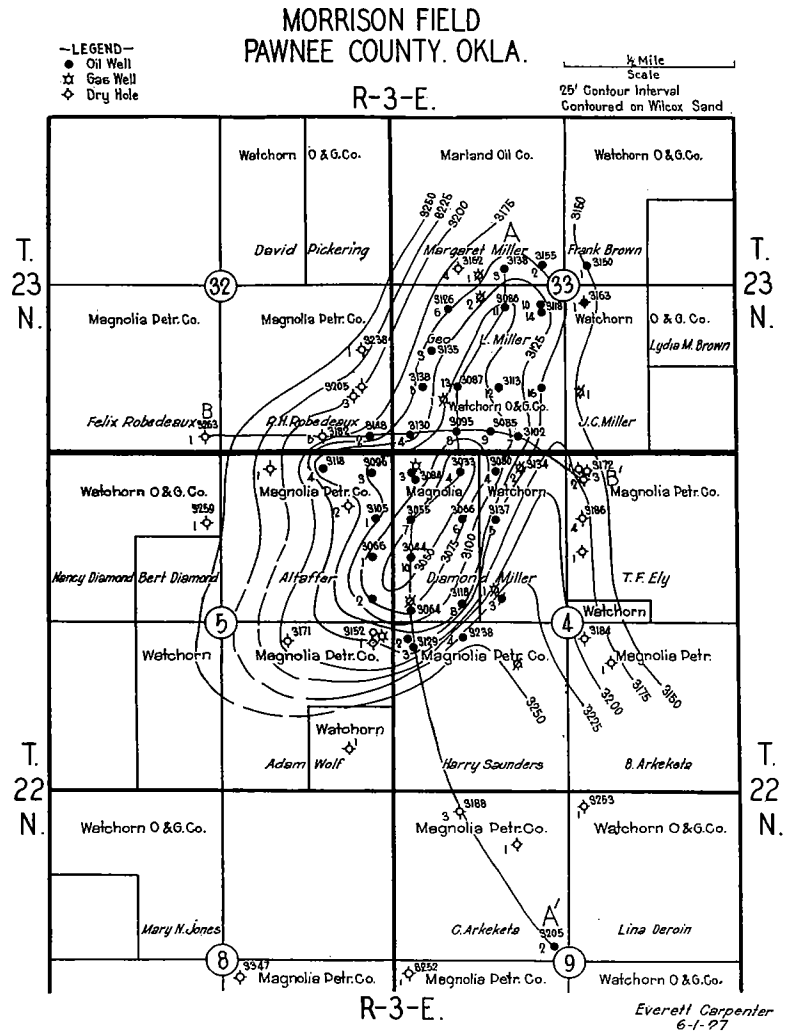

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Figure 6.—Geologic structure contoured on the "Wilcox" sand in feet below sea-level, Morrison field. Shows location of cross-sections **AA'** and **BB'** (Figs. 7 and 8).

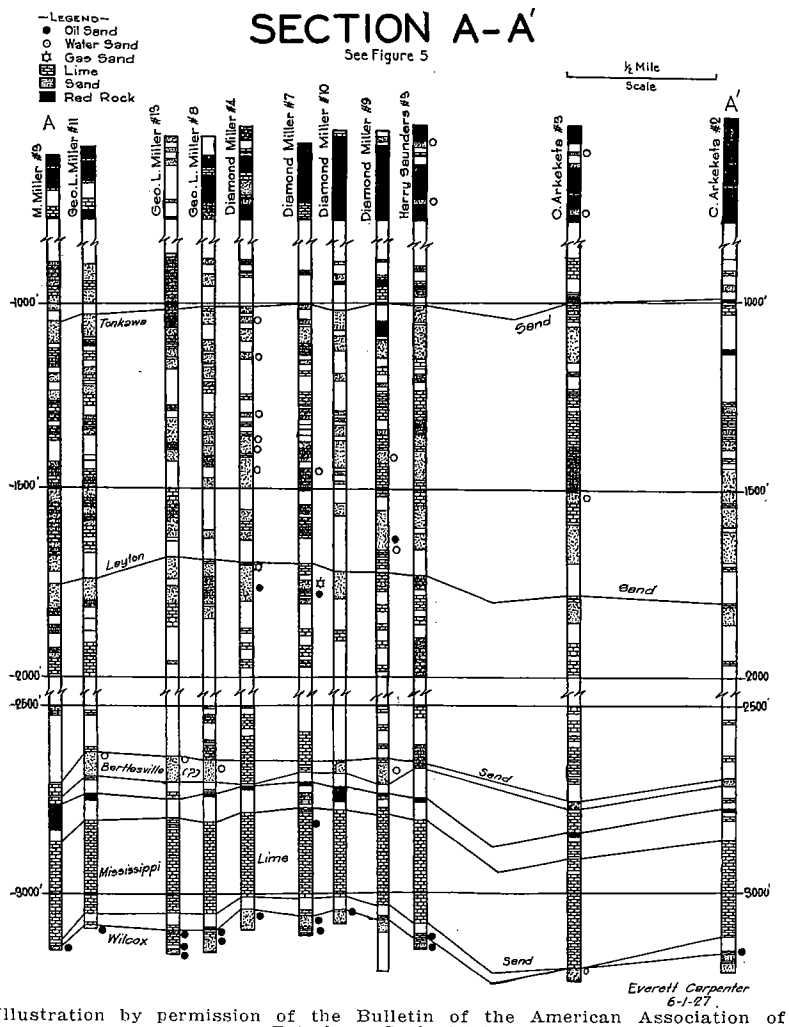

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Figure 7.—Geologic cross-section **AA'** as shown by well logs For location in field, see Figure 6. Depths shown in feet.

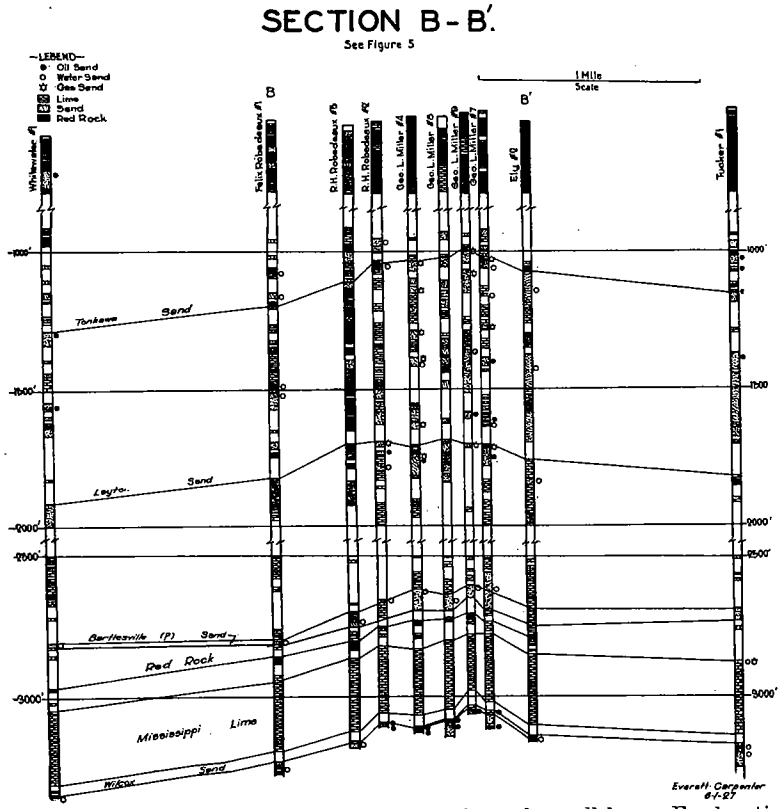

Figure 8.—Geologic cross-section **BB'** as shown by well logs. For location in field, see Figures 6. Depths shown in feet.

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